PATENT ABSTRACTS OF JAPAN

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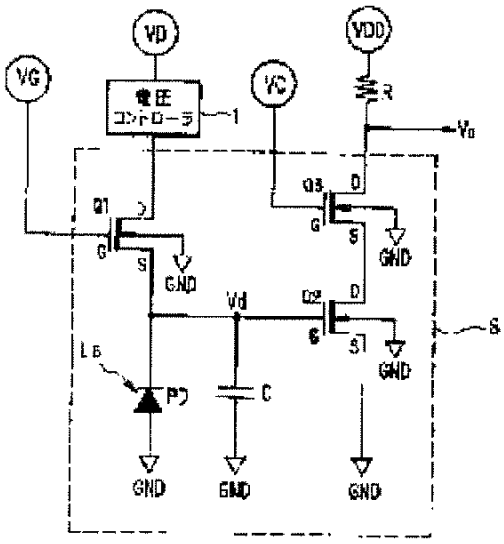
(54) OPTICAL SENSOR CIRCUIT



(57)Abstract:
PROBLEM TO BE SOLVED: To prevent an after-image from being generated even when a quantity of incident light is small by setting a drain voltage of a MOS transistor to be lower than a steady-state value for only a predetermined time when a light signal is to be detected, and discharging charges accumulated to a photoelectric conversion element connected to a source side to initialize a circuit.
SOLUTION: The optical sensor circuit consists of a photodiode PD, a MOS transistor Q1 for converting a sensor current to a voltage signal with a characteristic for outputting logarithmic characteristic, a MOS transistor Q2 for amplifying the voltage signal Vd, and a MOS transistor Q3 for pixel selection which outputs the amplified voltage signal as a pixel signal Vo. A voltage controller 1 is set for variably adjusting a size of a drain voltage VD of the MOS transistor Q1, thereby setting the drain voltage VD of the transistor Q1 to be a value lower than a steady-state value for only a predetermined time when a light signal is to be detected. Charges accumulated to a coupling capacitor C of the photodiode PD connected to a source side are discharged to initialize the circuit.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]In a photosensor circuit which changed into a voltage signal sensor current of an optoelectric transducer which detects a lightwave signal and is changed into an electrical signal with logarithmic output characteristics using a MOS transistor by a weak inverted state, A photosensor circuit establishing an initial setting means which only predetermined time is lower than a steady-state value, and sets up drain voltage of said MOS transistor when detecting a lightwave signal, is made to discharge an electric charge accumulated in a junction capacitance of an optoelectric transducer connected to the sauce side, and is initialized.
[Claim 2]A voltage signal into which sensor current of an optoelectric transducer was changed with logarithmic output characteristics by a MOS transistor is amplified by a MOS transistor for amplification, A photosensor circuit by statement of claim 1 using a thing it was made to output the amplified voltage signal via a MOS transistor for pixel selection as a component for 1 pixel of an image sensor.

TECHNICAL FIELD

[Industrial Application]This invention relates to the photosensor circuit which changes a lightwave signal into an electrical signal.

PRIOR ART

[Description of the Prior Art]If it is in an MOS type image sensor conventionally, As a photosensor circuit for the 1 pixel, as shown in drawing 7, the sensor current according to the light volume of the incident light Ls which flows into photo-diode PD as an optoelectric transducer is changed into the voltage signal Vd (both-ends voltage of photo-diode PD) by MOS transistor Q1, He amplifies the changed voltage signal Vd by MOS transistor Q2 for amplification, and is trying to output the amplified voltage signal as the pixel signal Vo as the pulse timing of gate control voltage VC is also by MOS transistor Q3 for pixel selection.
[0003]In that case, the electric charge is beforehand charged by the junction capacitance C of photo-diode PD (that by which the stray capacitance of wiring etc. was added to parasitic capacitance), and when an electric charge is discharged by the incident light Ls, sensor current will arise.
[0004]And in order to be in the photosensor circuit, to expand especially a dynamic range and to make it make a lightwave signal detect by high sensitivity, When the current which flows into a transistor is small, he is trying to give logarithmic output characteristics to MOS transistor Q1

using the resistance change showing the logarithmic characteristic.
[0005]In that case, it is the same as the drain voltage VD, or gate voltage VG of MOS transistor Q1 is set to less than it (each pressure value of VG and VD is fixed), and MOS transistor Q1 is operated by the weak inverted state.

EFFECT OF THE INVENTION

[Effect]As mentioned above, it is in the photosensor circuit which changed into the voltage signal the sensor current of the optoelectric transducer which detects a lightwave signal and is changed into an electrical signal in this invention with logarithmic output characteristics using the MOS transistor by the weak inverted state, When detecting a lightwave signal, only predetermined time is lower than a steady-state value, the drain voltage of said MOS transistor is set up, and the initial setting means which is made to discharge the electric charge accumulated in the junction capacitance of the optoelectric transducer connected to the sauce side, and is initialized is established.
Therefore, even if an abrupt change arises in sensor current, as the voltage signal according to the light volume of the incident light at that time is acquired immediately, even when there is little light volume of incident light, it has the advantage that producing an afterimage is lost.

DETAILED DESCRIPTION

[0001]
[Industrial Application]This invention relates to the photosensor circuit which changes a lightwave signal into an electrical signal.

[0002] [Description of the Prior Art]If it is in an MOS type image sensor conventionally, As a photosensor circuit for the 1 pixel, as shown in drawing 7, the sensor current according to the light volume of the incident light Ls which flows into photo-diode PD as an optoelectric transducer is changed into the voltage signal Vd (both-ends voltage of photo-diode PD) by MOS transistor Q1, He amplifies the changed voltage signal Vd by MOS transistor Q2 for amplification, and is trying to output the amplified voltage signal as the pixel signal Vo as the pulse timing of gate control voltage VC is also by MOS transistor Q3 for pixel selection.
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[0004]And in order to be in the photosensor circuit, to expand especially a dynamic range and to make it make a lightwave signal detect by high sensitivity, When the current which flows into a transistor is small, he is trying to give logarithmic output characteristics to MOS transistor Q1 using the resistance change showing the logarithmic characteristic.

[0005]In that case, it is the same as the drain voltage VD, or gate voltage VG of MOS transistor

Q1 is set to less than it (each pressure value of VG and VD is fixed), and MOS transistor Q1 is operated by the weak inverted state.

[0006] [Problem(s) to be Solved by the Invention]In the image sensor using the photosensor circuit which changed the sensor current of the optoelectric transducer into the voltage signal with logarithmic output characteristics using the MOS transistor by the weak inverted state, the problem which it is going to solve is that an afterimage arises, when the incident light quantity of an optoelectric transducer decreases.
[0007]When it is in the composition of drawing 7 and the incident light Ls has hit with sufficient light volume for photo-diode PD now, Sufficient sensor current for MOS transistor Q1 will flow, and since the resistance of MOS transistor Q1 is not so large, either, a lightwave signal can be made to detect with sufficient speed of response which does not produce an afterimage as an image sensor.
[0008]However, if the current which the light volume of the incident light Ls of photo-diode PD decreases, and flows into MOS transistor Q1 becomes small, From being set up operate so that the single figure of the resistance may become large if the single figure current which flows into it becomes small, MOS transistor Q1. It comes to take time to discharge the electric charge which the resistance of MOS transistor Q1 increased, and the damping time constant with the junction capacitance C became large, and was accumulated in the junction capacitance C of photo-diode PD. Therefore, an afterimage will be observed over a long time as the light volume of the incident light Ls decreases.
[0009]Drawing 3 shows the change characteristic of the voltage signal Vd when the sensor current of photo-diode PD changes rapidly from 1E-10A to 1E-15A.
[0010]In the sensor current which is about [with little light volume of the incident light Ls from this characteristic to photo-diode PD] 1E-12A, when making it make the pixel signal Vo output every 1/30 sec, it turns out that the voltage signal Vd is not saturated with within a time [that].
[0011]Therefore, since the saturation time of the voltage signal Vd according to sensor current when there is little light volume of the incident light Ls of photo-diode PD becomes long, if the pixel signal Vo is read by pulse timing as shown in drawing 8, the output of a level big at the beginning will serve as an afterimage, and will appear. Vd' shows the voltage signal in which reversal amplification was carried out by MOS transistor Q2 for amplification among drawing 8.
[0012]
[Means for Solving the Problem]This invention is in a photosensor circuit which changed into a voltage signal sensor current of an optoelectric transducer which detects a lightwave signal and is changed into an electrical signal with logarithmic output characteristics using a MOS transistor by a weak inverted state, Even if an abrupt change arises in sensor current, a voltage signal according to light volume of incident light at that time is acquired immediately, When it uses for an image sensor, and there is little light volume of incident light and a lightwave signal is detected to make it not produce an afterimage, only predetermined time is lower than a steady-state value, and drain voltage of said MOS transistor is set up, He is trying to establish an initial setting means which is made to discharge an electric charge accumulated in a junction capacitance of an optoelectric transducer connected to the sauce side, and is initialized.
[0013]
[Example]Drawing 1 shows the example of composition of the photosensor circuit when it uses as a component for 1 pixel of an image sensor.
[0014]Photo-diode PD as an optoelectric transducer from which the photosensor circuit changes

a lightwave signal into an electrical signal, MOS transistor Q1 which changes into a voltage signal the sensor current which flows into photo-diode PD according to the light volume of the incident light Ls with logarithmic characteristic output characteristics by a weak inverted state, It consists of MOS transistor Q2 which amplifies the changed voltage signal (terminal voltage of photo-transistor PD) Vd, and MOS transistor Q3 for pixel selection which outputs the amplified voltage signal as the pixel signal Vo.

[0015]C shows among the figure the junction capacitance of photo-diode PD by which the stray capacitance of wiring etc. was added to parasitic capacitance equivalent.

[0016]VG is a gate power source of the immobilization for operating photo-diode PD by the weak inverted state of the low voltage. VC is a power supply for gate control for making MOS transistor Q3 for pixel selection switch. It is for the fixed power source VDD for bias and the resistance R making the output level of the pixel signal Vo predetermined.

[0017]VD is a power supply for the drain voltage of MOS transistor Q1.

[0018]Especially in this invention, the voltage controller 1 which adjusts the size of the drain voltage VD of MOS transistor Q1 to variable is formed, When detecting a lightwave signal, only predetermined time sets the drain voltage VD of MOS transistor Q1 as a pressure value (or zero value) lower than a steady-state value rather than a steady-state value (high-level), He makes the electric charge accumulated in the junction capacitance C of photo-diode PD connected to the sauce side discharge, and is trying to initialize.

[0019]Drawing 2, A lightwave signal. When detecting, the drain voltage VD of MOS transistor Q1. The timing of initialization which switches voltage lower than the steady-state value (high level H) between the predetermined time tm (for example, it becomes about 5microsec when the read-out speed for 1 pixel is about 100 msec) to (the low level L), and MOS transistor Q3 for pixel selection. The timing of lightwave signal read-out by gate control voltage VC made into a switch ON state is shown. T shows the storage period of the junction capacitance C of photo-diode PD among the figure, and, in the case of an NTSC signal, the accumulation period T serves as a 1/30-sec (or 1/60 sec) grade.

[0020]If it is in some which were constituted in this way, under control of the voltage controller 1, If the drain voltage VD of MOS transistor Q1 is switched to the low level L at the time of initialization, and the potential difference between gate voltage VG at that time and the drain voltage VD is larger than the threshold of MOS transistor Q1, MOS transistor Q1 will be in a low resistance state. The potential by the side of the sauce at that time will become the same as the drain voltage VD by that cause (the potential difference for a threshold remains actually), and the junction capacitance C of photo-diode PD will be in a discharge state.

[0021]And under control of the voltage controller 1, if switched after tm passage of time by the high level H with the regular drain voltage VD, The potential by the side of sauce becomes lower than the drain voltage VD, if the potential difference between gate voltage VG at that time and the drain voltage VD is larger than a threshold, MOS transistor Q1 will be in a low resistance state, and the junction capacitance C of photo-diode PD will be in a charging state.

[0022]Thus, if it is made to make the junction capacitance C charge after making the junction capacitance C of photo-diode PD discharge prior to detection of a lightwave signal and initializing, The output voltage (terminal voltage of photo-diode PD) Vd in the fixed time of carrying out time progress serves as a value according to the light volume of the incident light Ls from the timing of the initialization. That is, after initialization, the discharge characteristic by the fixed damping time constant which followed in footsteps of change of the light volume of the incident light Ls comes to be obtained.

[0023]Although the current which will be supplied through MOS transistor Q1 from the drain voltage VD in that case if it is neglected for a long time, and the current which flows through photo-diode PD become the same, since the always same discharge characteristic will be obtained if there is no electric charge which remained before, it is lost that an afterimage arises of it.

[0024]Therefore, if fixed time is set and a lightwave signal is read after initializing, the pixel signal Vo without the afterimage according to the light volume of the incident light Ls can be acquired.
[0025]Drawing 3 is in the change characteristic of the voltage signal Vd when the sensor current of photo-diode PD changes rapidly from 1E-10A to 1E-15A, and after initializing, the time of setting up the timing of read-out of a lightwave signal after fixed 1/30 sec of time progress is shown.
[0026]Drawing 4 shows the characteristic of the amplified signal of the voltage signal Vd at the time of repeating read-out of a lightwave signal and making it perform in the timing of 1/30 sec. According to this, it turns out that the signal characteristic acquired every 1/30 sec becomes a thing adapted to the sensor current according to the light volume of the incident light Ls to photo-diode PD, and there is no influence of an afterimage.

[0027]Drawing 5 shows the output characteristics (a) of the pixel signal Vo when changing the light volume of the incident light Ls to photo-diode PD. According to this, it turns out that the sensor current of photo-diode PD serves as logarithmic output characteristics thoroughly above 1E-13A. Although sensor current separates from the logarithmic characteristic in the field below 1E-13A, it turns out that an output without an afterimage is obtained.
[0028]If the low level L of the voltage VD controlled by the voltage controller 1 is adjusted, and voltage is dropped until MOS transistor Q1 is thoroughly made to a low resistance state, output characteristics as shown by (a) among drawing 5 will be obtained. However, when the control voltage VD is set up become the same as that of gate voltage VG, the usual logarithmic output

characteristics as shown by (b) among drawing 5 will be obtained. [0029]Therefore, in the case of the output characteristics shown by (a) among drawing 5, there is no afterimage, but sensitivity becomes small when there is little light volume. Even when there is little light volume in the case of the logarithmic output characteristics shown by (b) among drawing 5, sensitivity is large, but an afterimage becomes remarkable. That is, the relation of a trade-off is materialized between sensitivity and an afterimage.

[0030]Therefore, by adjusting the control voltage VD so that output characteristics may come to a middle field with the logarithmic output characteristics shown by (b) among the output characteristics shown by (a) among drawing 5, and drawing 5, For the use which does not make an issue of an afterimage, it can be considered as setting out which gives priority to sensitivity, and can be considered now as setting out which considers abolishing an afterimage as priority in the use from which an afterimage poses a problem. It is possible to adjust the control voltage VD actually according to the grade of the afterimage which does not become a problem according to a use, and to set up sensitivity as greatly as possible.

[0031]Drawing 6 shows the example of composition when the photosensor circuit shown in drawing 1 is allocated in the shape of two dimensions as sensor element [for 1 pixel] S and an image sensor is formed.

[0032]One is the pixel selection circuit in which 2 was able to form the voltage controller formed common to each sensor element S common to each sensor element S among drawing 6. The signal selection circuit 3 for making the pixel signal Vo of each sensor element S output one by one is formed.

[0033]According to such composition, there is no afterimage and an image sensor with the large logarithmic output characteristics of the dynamic range can be realized now.

[0034] [Effect]As mentioned above, it is in the photosensor circuit which changed into the voltage signal the sensor current of the optoelectric transducer which detects a lightwave signal and is changed into an electrical signal in this invention with logarithmic output characteristics using the MOS transistor by the weak inverted state, When detecting a lightwave signal, only predetermined time is lower than a steady-state value, the drain voltage of said MOS transistor is set up, and the initial setting means which is made to discharge the electric charge accumulated in the junction capacitance of the optoelectric transducer connected to the sauce side, and is initialized is established.

Therefore, even if an abrupt change arises in sensor current, as the voltage signal according to the light volume of the incident light at that time is acquired immediately, even when there is little light volume of incident light, it has the advantage that producing an afterimage is lost.

EXAMPLE

[Example]Drawing 1 shows the example of composition of the photosensor circuit when it uses as a component for 1 pixel of an image sensor.

[0014]Photo-diode PD as an optoelectric transducer from which the photosensor circuit changes a lightwave signal into an electrical signal, MOS transistor Q1 which changes into a voltage signal the sensor current which flows into photo-diode PD according to the light volume of the incident light Ls with logarithmic characteristic output characteristics by a weak inverted state, It consists of MOS transistor Q2 which amplifies the changed voltage signal (terminal voltage of photo-transistor PD) Vd, and MOS transistor Q3 for pixel selection which outputs the amplified voltage signal as the pixel signal Vo.

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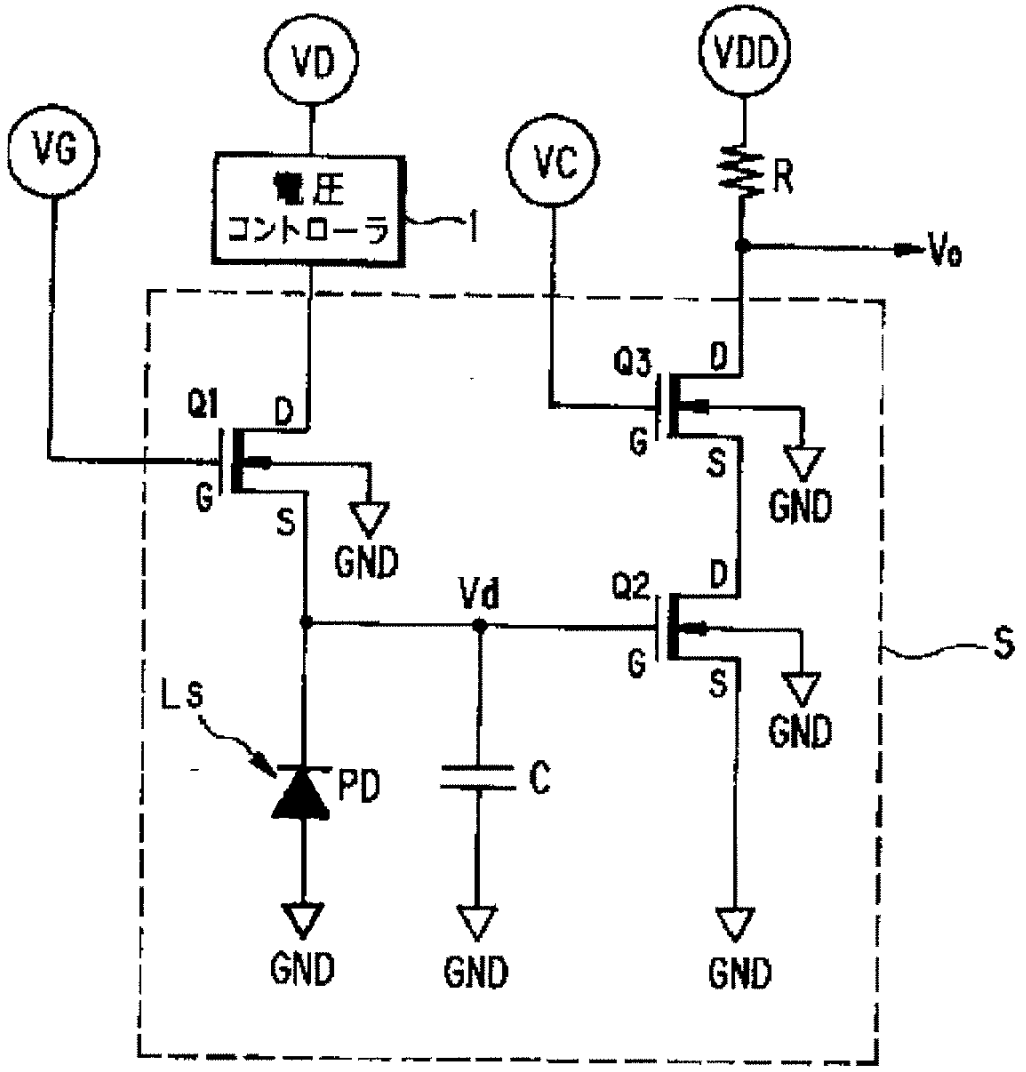
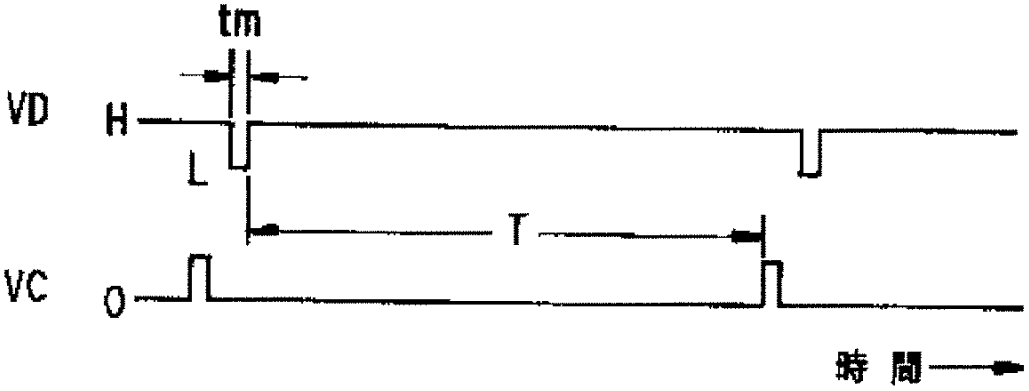


Drawing 1



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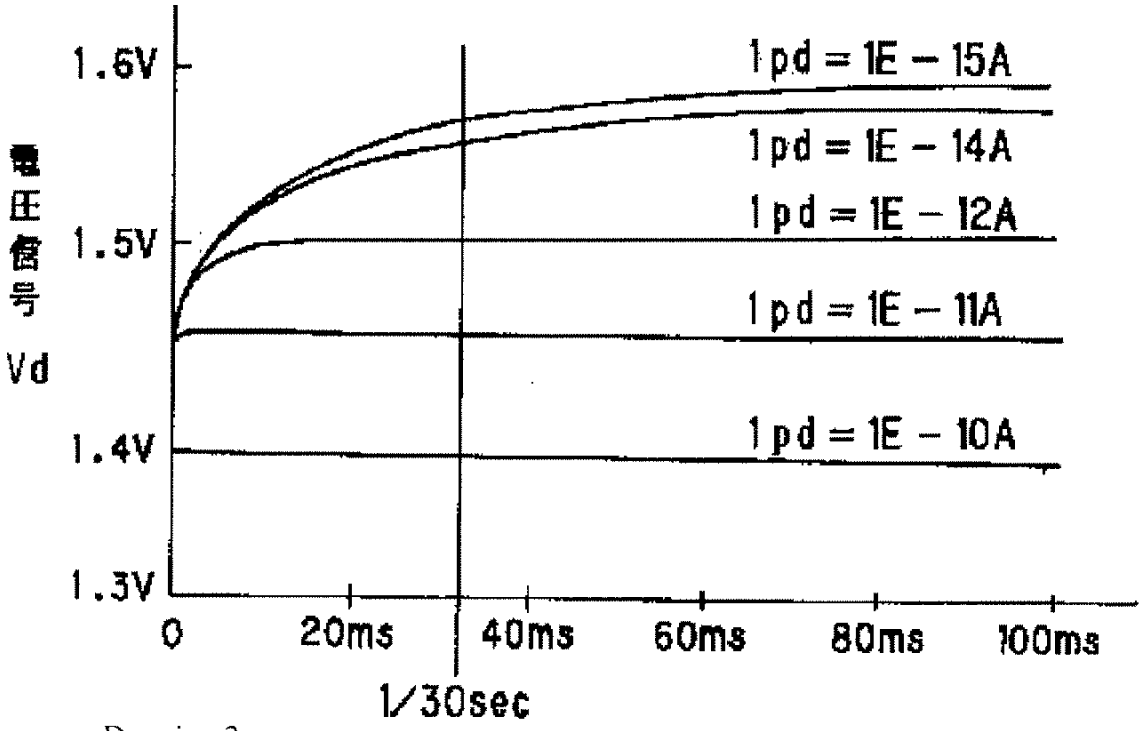

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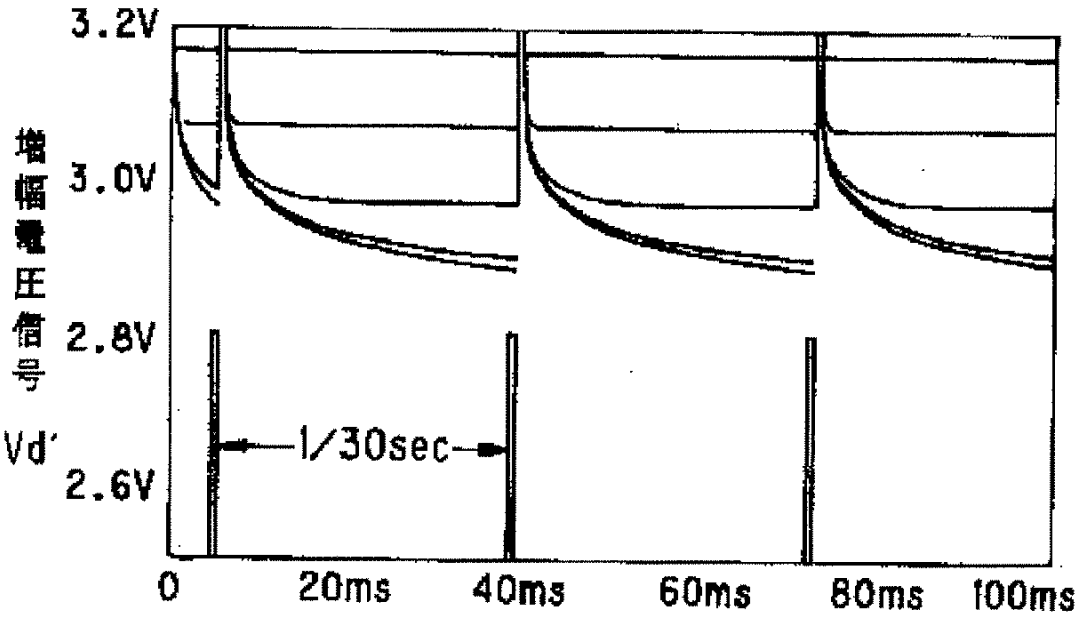
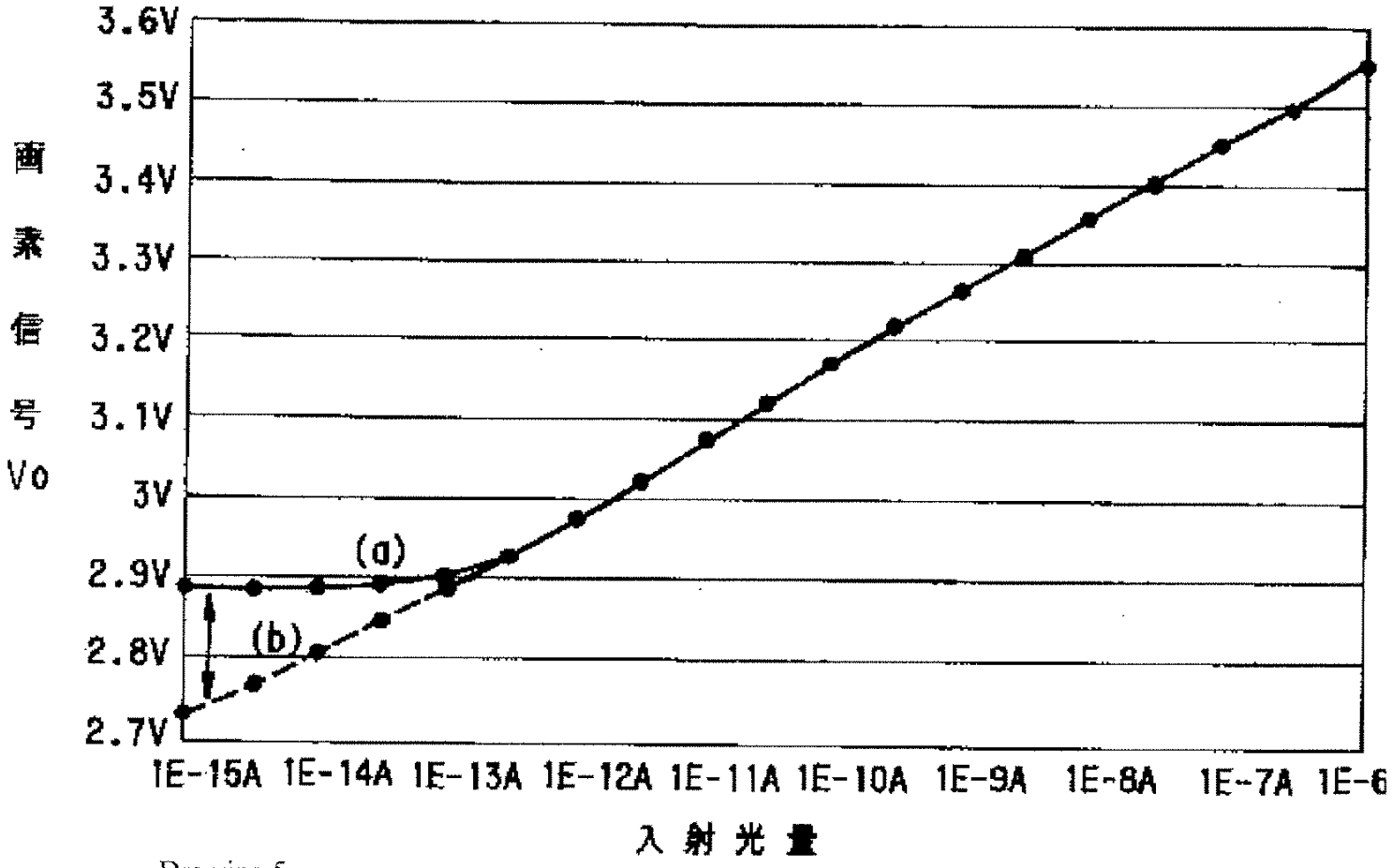


Drawing 4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(a)
(b)
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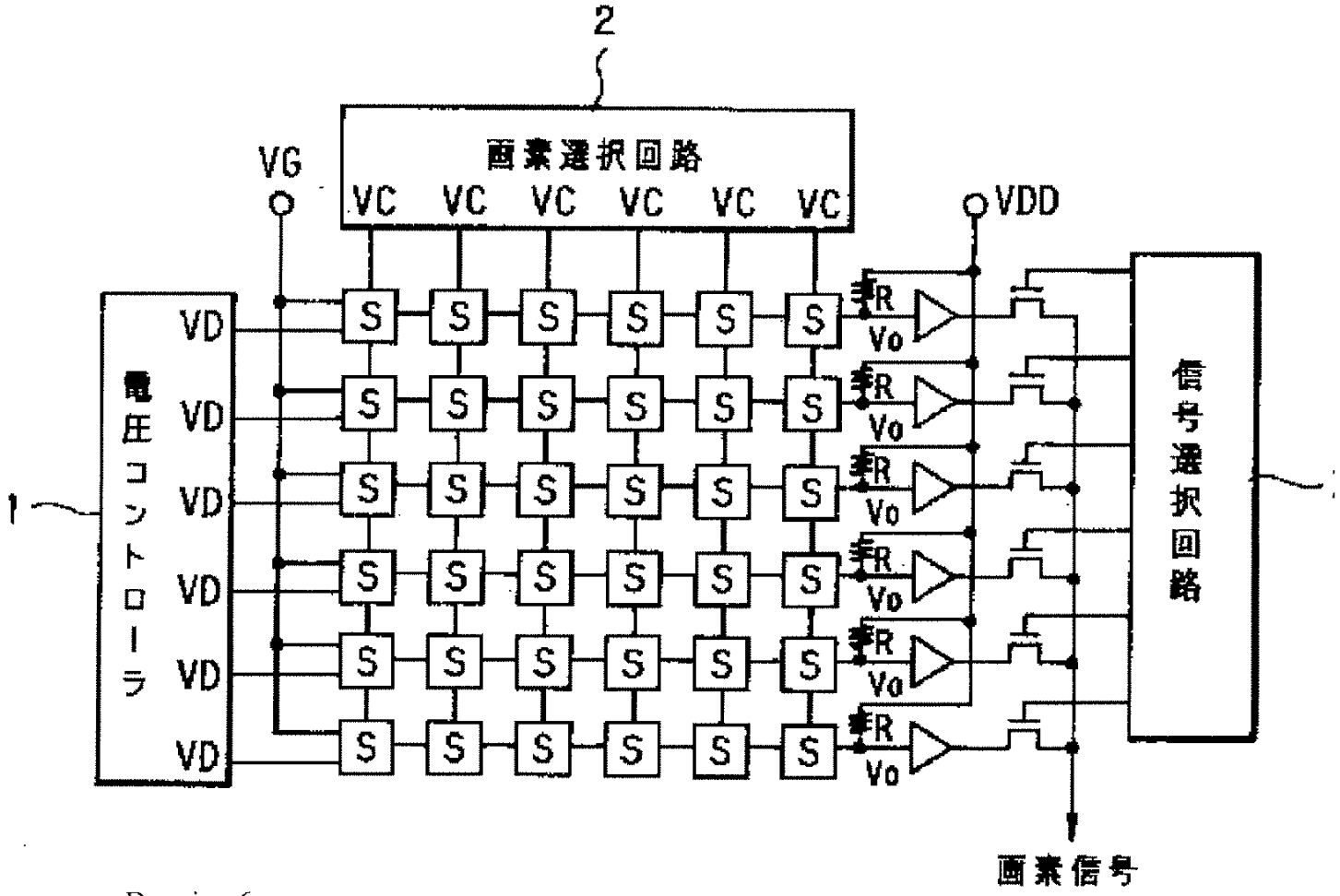
Drawing 5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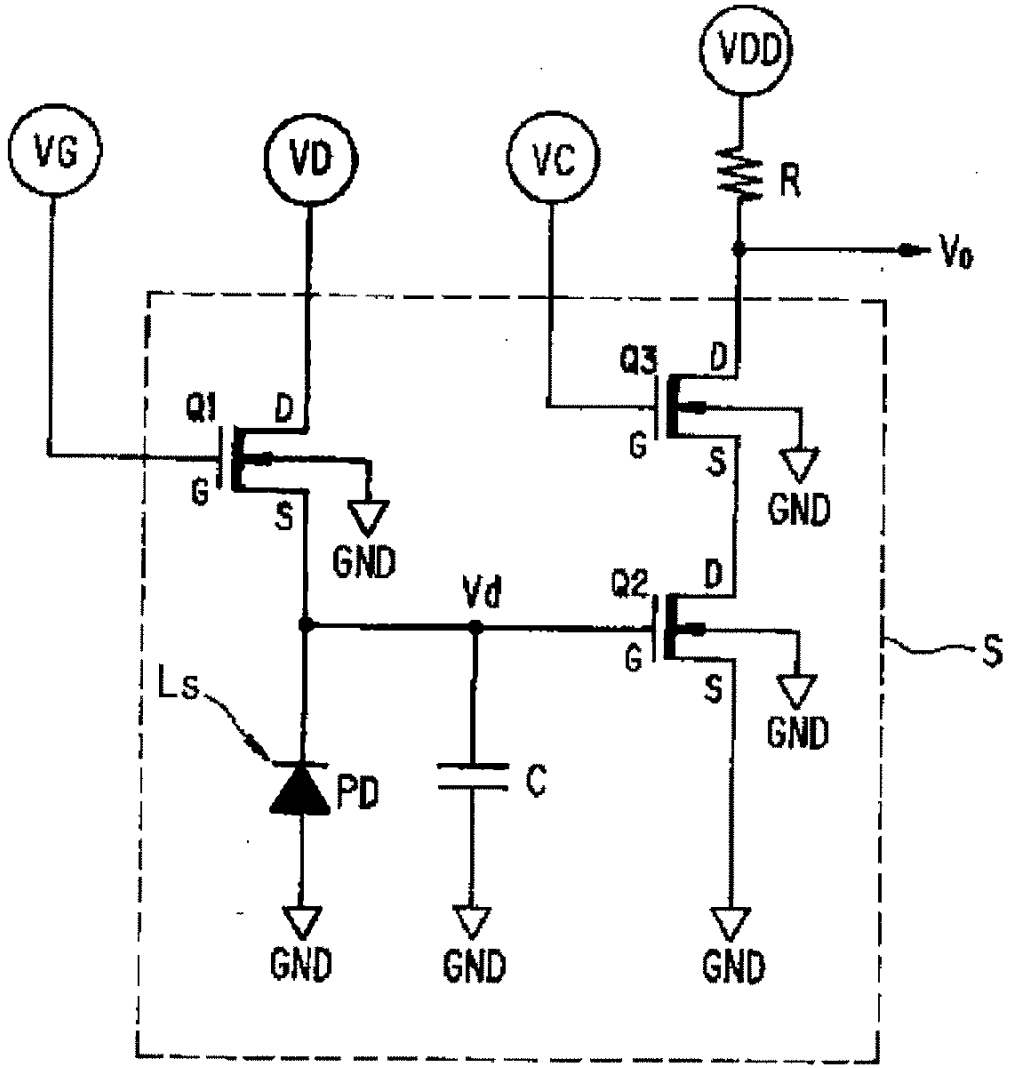
Drawing 6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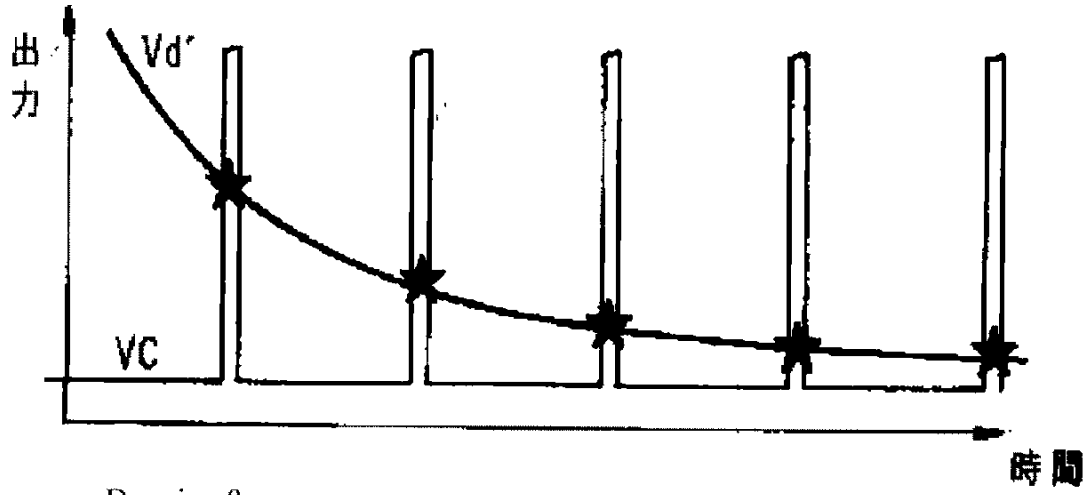
Drawing 7



Drawing 8